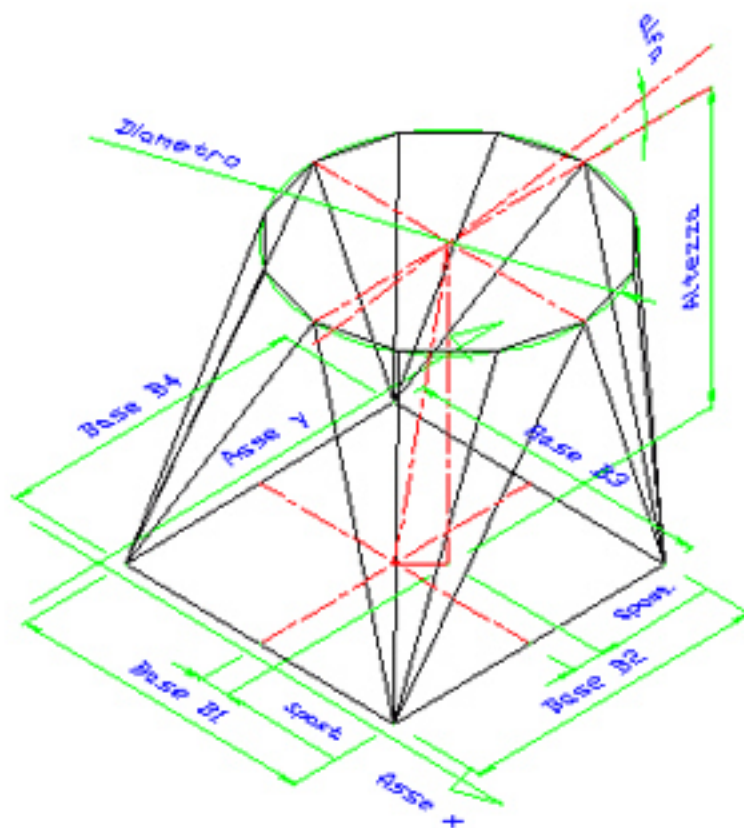
Tracciatura componenti di Caldareria e Piping

25 programmi in Autolisp

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INTRODUZIONE

Questo quaderno si rivolge principalmente ai Tecnici delle officine di prefabbricazione di componenti di caldareria e piping. Scopo del lavoro è fornire a costoro uno strumento che, attraverso l'uso del computer e con pochi dati in input, esegua immediatamente la tracciatura degli sviluppi in piano di quelle superfici 3D (e loro intersezioni) che maggiormente ricorrono nella pratica costruttiva dei componenti per caldareria e piping. Alle aziende che adoperano, per il taglio delle lamiere, impianti con pantografo a controllo numerico, si segnala che i programmi contenuti nel quaderno danno outputs grafici che sono subito utilizzabili per il "nesting" e la programmazione del taglio dei fogli di lamiera.

Nei 25 casi pubblicati in questo quaderno, gli oggetti sono trattati in forma parametrica. I parametri sono costituiti da un insieme di dati il cui numero è quello strettamente necessario per definire la geometria dell'oggetto in modo univoco. Al variare dei parametri (nel loro insieme di definizione) si ottengono le geometrie di tutti i possibili (infiniti) oggetti reali del caso considerato.

In una trattazione teorica, le superfici di intersezione considerate nei vari casi avrebbero avuto spessore = zero. Nella pratica, essendo i componenti reali ricavati da lamiera, si deve tenere conto dello spessore di questa. All'occorrenza si introduce perciò il parametro "RN". La scelta delle superfici di intersezione è infatti legata al tipo di giunzione saldata adottato per l'unione dei componenti. Non sempre le superfici scelte coincidono con quelle cosiddette "neutre", quelle cioè che non subiscono alcuna deformazione, a causa dello stiramento o compressione delle fibre, in seguito alla calandratura delle lamiere. "RN" è quindi il "raggio neutro" da usare per il calcolo dello sviluppo della virola da calandrare. Per piccoli spessori e grandi raggi di curvatura, il raggio neutro è ben approssimato dal raggio medio della virola; in generale, RN è una funzione del raggio, dello spessore e del materiale della lamiera e si trova su tabelle nelle pubblicazioni
specializzate.

Nella sezione "Formule" di ciascun articolo, sono riportate le modalità di costruzione grafica e le espressioni analitiche che se ne traggono e che sono servite per la stesura dei programmi AutoLISP. Una delle migliori funzioni di AutoCAD è la possibilità di personalizzare software attraverso un linguaggio di programmazione. Per la creazione dei programmi contenuti in questo quaderno si è utilizzato AutoLISP, che è il più semplice tra i linguaggi che comunicano con AutoCAD. I programmi AutoLISP sono stati scritti nell'editor di testi della versione DOS, che è accessibile direttamente dall'interno di AutoCAD digitando "EDIT". Ciascun programma, salvato in un file con estensione .LSP, può essere utilizzato in qualsiasi momento come un comando AutoCAD, caricandolo nell'editor grafico ed inserendone il nome al prompt di comando. Per caricare il programma (con la versione 14 di AutoCAD) si usa l'opzione "Load Application" che si trova nel menu "Tools". Prima di lanciare i programmi i modi "osnap" ed "ortho" devono essere disattivati.

Si vede quindi come gli strumenti prodotti con questo lavoro abbiano carattere "artigianale", essendo destinati ad utenti in possesso di requisiti minimi, quali l'accesso ad un computer in grado di eseguire la versione 12 o 13 di AutoCAD, sotto Windows o DOS, ed almeno le conoscenze di base del software per la grafica.

Una caratteristica comune a tutti i programmi AutoLISP realizzati è l'uso dei "cicli" per la creazione delle curve da una serie di vettori. Il numero dei vettori, che corrisponde al numero degli incrementi dell'angolo "A" per la ripetizione ciclica delle istruzioni, può essere variato a piacere, onde ottenere la "precisione" voluta della curva.

Per quel che riguarda l'affidabilità di ogni singolo programma, questa risulta garantita da quanto segue:

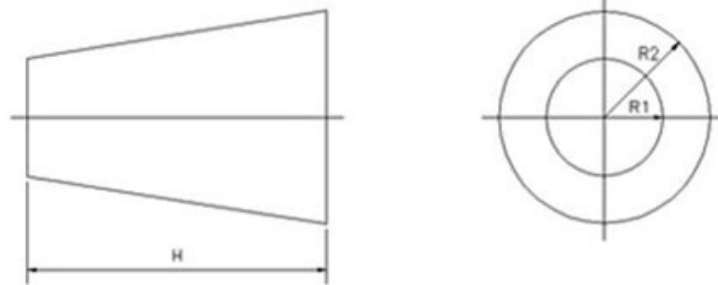
- Sono stati sempre eseguiti test di "sovrapposizione" delle curve ottenute da ciascun programma con le stesse curve ottenute usando AutoCAD ed i metodi di costruzione grafica tradizionali.
- Ciascun programma è stato poi utilizzato, almeno una volta, in casi reali con risultato favorevole.

Resta comunque la possibilità di verificare la correttezza dei singoli programmi attraverso una attenta analisi delle costruzioni grafiche, delle espressioni analitiche che ne derivano e dei listati AutoLISP contenuti in ciascun articolo della presente pubblicazione. Si compie così un esercizio che risulta altresì utile per chi voglia ripassare o approfondire gli argomenti.

NOTA

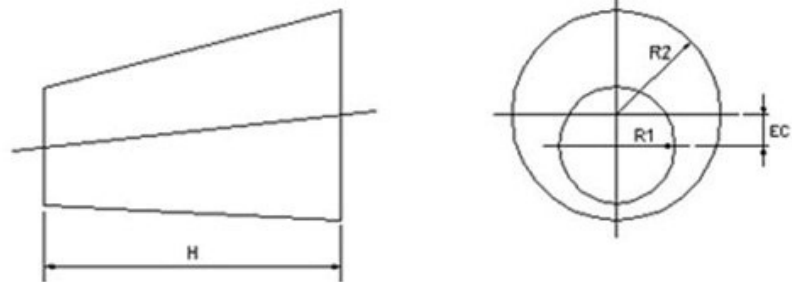
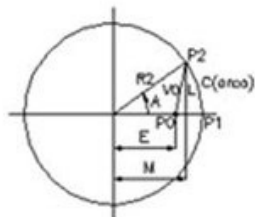
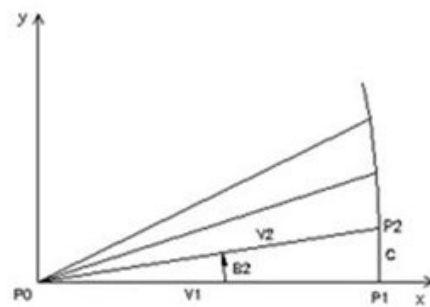
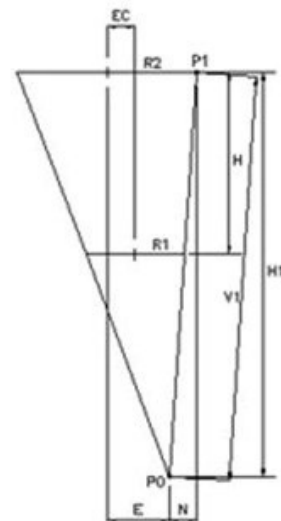
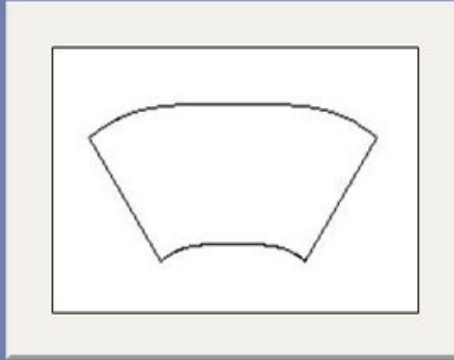
I programmi dal n.5 al n.16 risolvono una intera "famiglia" di intersezioni fra cilindri il cui caso più generale è trattato ai n. 11 e 12. Infatti, tutte le altre situazioni si ottengono da queste ultime azzerando opportunamente alcuni parametri.

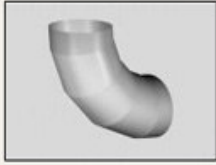
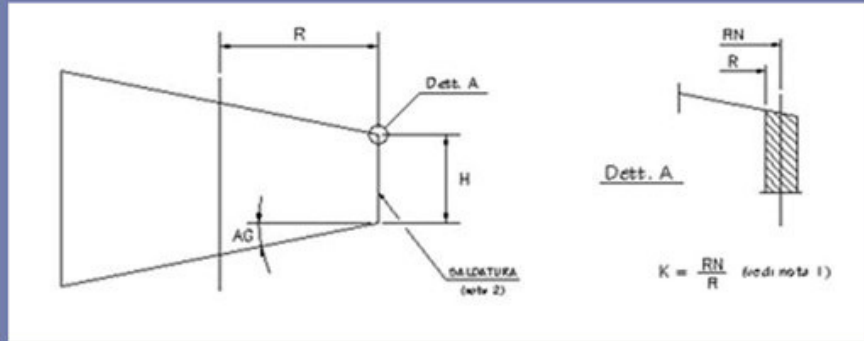
PROGRAMS

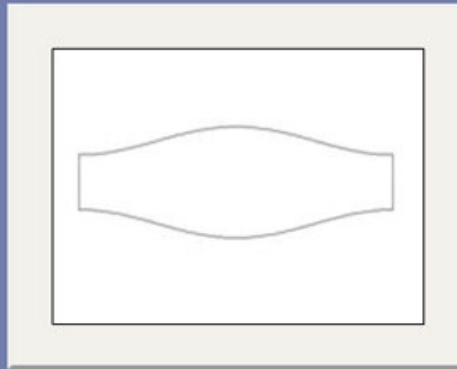
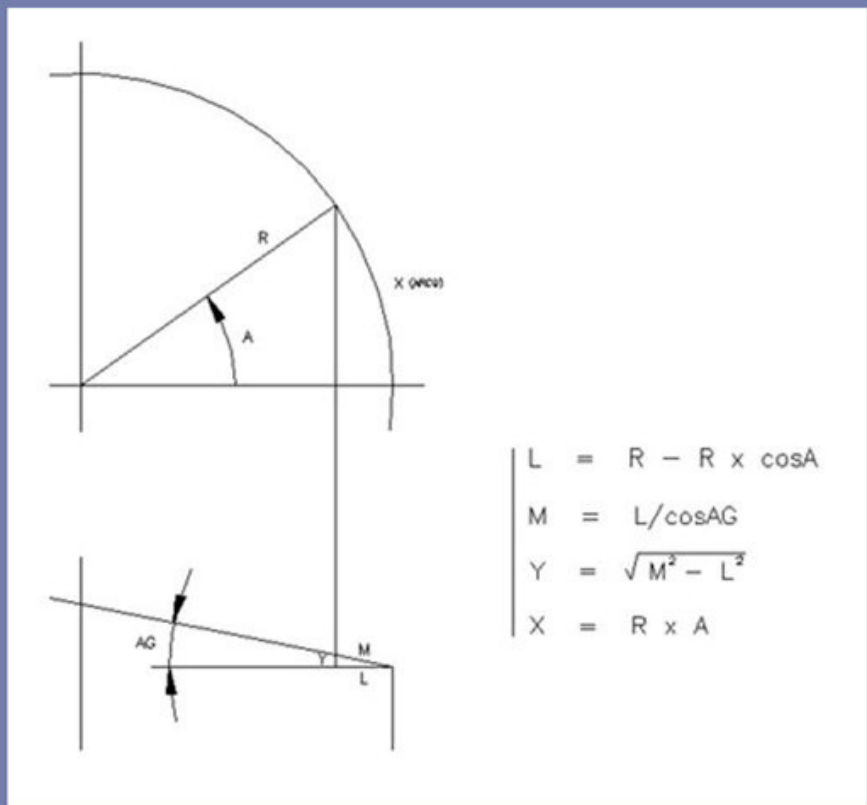
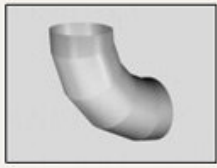
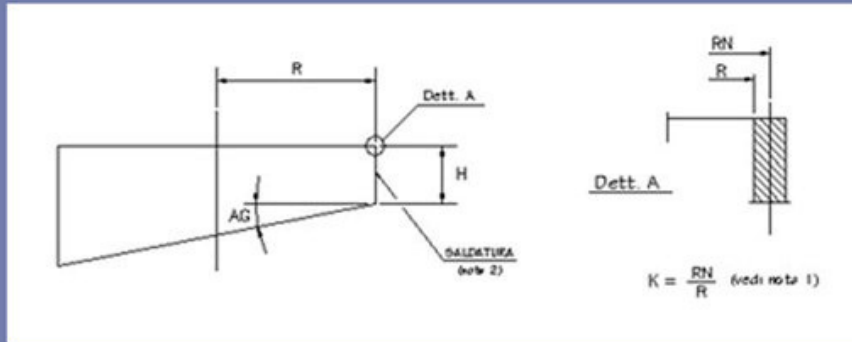
No.	Program	No.	Program
1	CONCENTRIC REDUCER	2	EXCENTRIC REDUCER
3	ELBOW - INNER SEGMENT	4	ELBOW - LAST SEGMENT
5	STRAIGHT INTERSECTION BETWEEN CYLINDERS NOZZLE	6	STRAIGHT INTERSECTION BETWEEN CYLINDERS OPENING
7	STRAIGHT AND EXCENTRIC INTERSECTION BETWEEN CYLINDERS NOZZLE	8	STRAIGHT AND EXCENTRIC INTERSECTION BETWEEN CYLINDERS OPENING
9	OBLIQUE INTERSECTION BETWEEN CYLINDERS NOZZLE	10	OBLIQUE INTERSECTION BETWEEN CYLINDERS OPENING
11	OBLIQUE AND EXCENTRIC INTERSECTION BETWEEN CYLINDERS NOZZLE	12	OBLIQUE AND EXCENTRIC INTERSECTION BETWEEN CYLINDERS OPENING
13	EQUAL TEE NOZZLE	14	EQUAL TEE OPENING
15	OBLIQUE EQUAL TEE NOZZLE	16	OBLIQUE EQUAL TEE OPENING
17	CYLINDER-SPHERE INTERSECTION NOZZLE	18	CYLINDER-TORUS INTERSECTION NOZZLE
19	CYLINDER-CONE STRAIGHT INTERSECTION NOZZLE	20	CYLINDER-CONE STRAIGHT INTERSECTION OPENING
21	CYLINDER-CONE STRAIGHT AND EXCENTRIC INTERSECTION NOZZLE	22	CYLINDER-CONE STRAIGHT AND EXCENTRIC INTERSECTION OPENING
23	CYLINDER-CONE PARALLEL INTERSECTION NOZZLE	24	CYLINDER-CONE PARALLEL INTERSECTION OPENING
25	SQUARE-CIRCLE REDUCER		

PROGRAM: CONO.lsp

```
(DEFUN C:CONO ()
   (GRAPHSCR)
      (SETQ R1 (GETREAL "\nIMMETTERE RAGGIO R1: ")
            R2 (GETREAL "\nIMMETTERE RAGGIO R2: ")
            H (GETREAL "\nIMMETTERE ALTEZZA H: ")
            PO (GETPOINT "\nPUNTO INIZIALE: ")
      )
         (SETQ PO (LIST 0 0)
               L (- R2 R1)
               M (SQRT (+ (* L L) (EXPT H 2)))
               R11 (* (/ M L) R1)
               R21 (+ M R11)
               A (* (/ R2 R21) PI)
         )
            (SETQ P1 (POLAR PO (- (/ PI 2) A) R11)
                  P2 (POLAR PO (- (/ PI 2) A) R21)
                  P3 (POLAR PO (+ (/ PI 2) A) R21)
                  P4 (POLAR PO (+ (/ PI 2) A) R11)
            )
               (COMMAND "LINE" P1 P2 ""
                        "ARC" "C" PO P2 P3 ""
                        "LINE" P3 P4 ""
                        "ARC" "C" PO P1 P4 ""
               )
                  (COMMAND "ZOOM" "ALL" "")
                  (PRINC)
)
```

OUTPUT
GRAPHIC CONSTRUCTION AND FORMULAS
R2
L
H
M
R1
R21
R11
y
P3
P2
P4
P1
A
x
P0
L = R2 − R1
M = √L² + H²
R11 = (M/L) x R1
R21 = M + R11
A = (R2/R21) x π

2
EXCENTRIC REDUCER
DATA
R2
R1
EC
H
GRAPHIC CONSTRUCTION AND FORMULAS
EC
R2
P1
H
R1
H1
V1
P0
E
N
y
V2
P2
C
B2
P0
V1
P1
x
P2
R2
C(arco)
A
V0
L
P0
P1
E
M
M = R2 x cosA
L = R2 x sinA
H1 = R2 x H/(R2−R1)
C = R2 x A
V0 = √(M−E)² + L²
V2 = √ V0² + H1²
P = (C+V1+V2)/2
S = √ (P−C)x(P−V1)x(P−V2)/P
T = S/(P−C)
B2 = 2 x atanT
E = EC x H1/H
N = R2 − E
V1 = √ N² + H1²

PROGRAM: COBB.lsp

```
(DEFUN C:COBB ()
  (GRAPHSCR)
    (SETQ R1 (GETREAL "\nIMMETTERE RAGGIO R1: ")
          R2 (GETREAL "\nIMMETTERE RAGGIO R2: ")
          EC (GETREAL "\nIMMETTERE ECCENTRICITA' EC: ")
          H (GETREAL "\nIMMETTERE ALTEZZA H: ")
          P1 (GETPOINT "\nPUNTO INIZIALE: ")
    )
      (SETQ H1 (/ (* R2 H) (- R2 R1)))
      (SETQ E (* EC (/ H1 H)))
      (SETQ N (- R2 E))
      (SETQ V1 (SQRT (+ (* N N) (EXPT H1 2))))
      (SETQ P1 (LIST V1 0))
      (SETQ P0 (LIST 0 0))
      (SETQ B1 0)
      (SETQ A (/ PI 90))
      (SETQ C (* R2 A))
        (REPEAT 90
          (SETQ M (* R2 (COS A))
                L (* R2 (SIN A))
                V0 (SQRT (+ (* L L) (EXPT (- M E) 2)))
                V2 (SQRT (+ (* V0 V0) (EXPT H1 2)))
                P (/ (+ (+ C V1) V2) 2)
                D1 (- P C)
                D2 (- P V1)
                D3 (- P V2)
                S (SQRT (/ (* D1 (* D2 D3)) P))
                T (/ S D1)
                B2 (+ (* (ATAN T) 2) B1)
                P2 (POLAR P0 B2 V2)
          )
            (COMMAND "LINE" P1 P2 "")
            (SETQ P1 P2)
            (SETQ V1 V2)
            (SETQ B1 B2)
            (SETQ A (+ A (/ PI 90)))
        )
            (COMMAND "COPY" "ALL" "" P0 P0 "")
            (SETQ K (/ (- H1 H) H1))
            (COMMAND "SCALE" "PREVIOUS" "" P0 K "")
            (COMMAND "LINE" P1 P0 "")
            (COMMAND "MIRROR" "ALL" "" P0 (LIST 1 0) "")
            (COMMAND "TRIM" "ALL" "" P0 P0 "")
            (COMMAND "ROTATE" "ALL" "" P0 90 "")
            (COMMAND "ZOOM" "ALL" "")
            (PRINC)
)
```

PROGRAM: SPICCHI.lsp

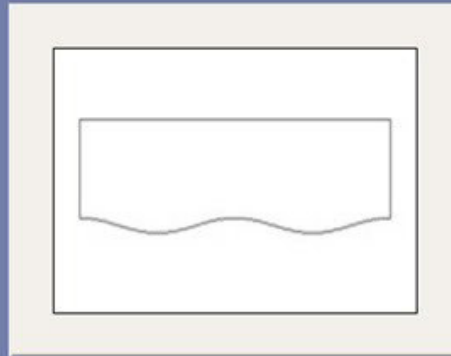
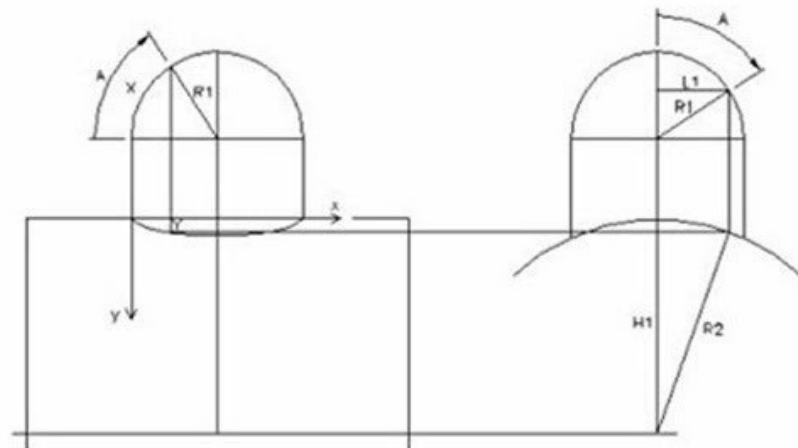
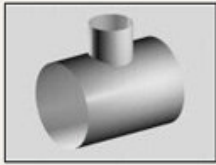
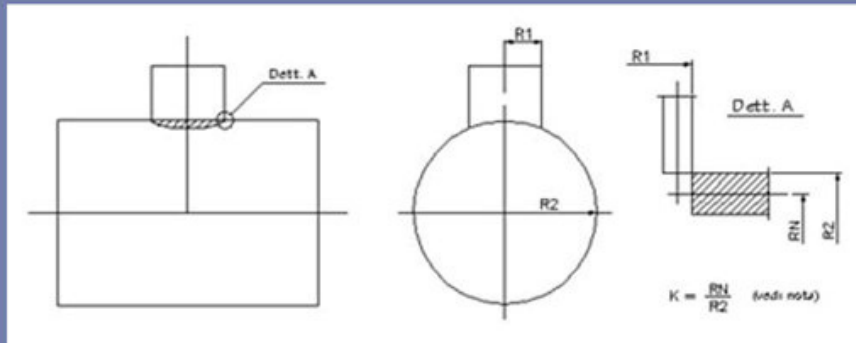
```
(DEFUN C:SPICCHI ()
   (GRAPHSCR)
      (SETQ AG (GETREAL "\nIMMETTERE ANGOLO AG: ")
            R (GETREAL "\nIMMETTERE RAGGIO R: ")
            RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
            H (GETREAL "\nIMMETTERE 1/2 ALTEZZA H: ")
            P1 (GETPOINT "\nPUNTO INIZIALE: ")
      )
         (SETQ P1 (LIST 0 0))
         (SETQ A (/ PI 90))
            (REPEAT 180
               (SETQ L (- R (* R (COS A)))
                     M (/ L (COS (* (/ PI 180) AG)))
                     Y (SQRT (- (* M M) (EXPT L 2)))
                     K (/ RN R)
                     X (* (* K R) A) P2 (LIST X Y)
               )
                  (COMMAND "LINE" P1 P2 "")
                  (SETQ P1 P2)
                  (SETQ A (+ A (/ PI 90)))
            )
                  (SETQ P3 (LIST (CAR P2) (- 0 H)))
                  (SETQ P4 (LIST 0 (- 0 H)))
                  (SETQ P5 (LIST 0 0))
                  (COMMAND "LINE" P2 P3 "")
                  (COMMAND "LINE" P4 P5 "")
                  (COMMAND "MIRROR" "ALL" "" P3 P4 "")
                  (COMMAND "ZOOM" "ALL" "")
                  (COMMAND "UCS" "P")
                  (PRINC)
)
```

OUTPUT
GRAPHIC CONSTRUCTION
AND FORMULAS
R
A
X (ARCO)
AG
Y
M
L
L = R − R x cosA
M = L/cosAG
Y = √ M² − L²
X = R x A

PROGRAM: MSPICCHI.lsp

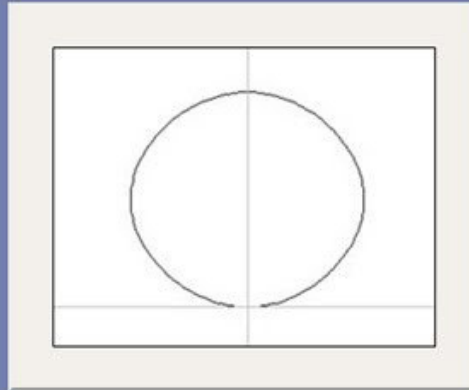
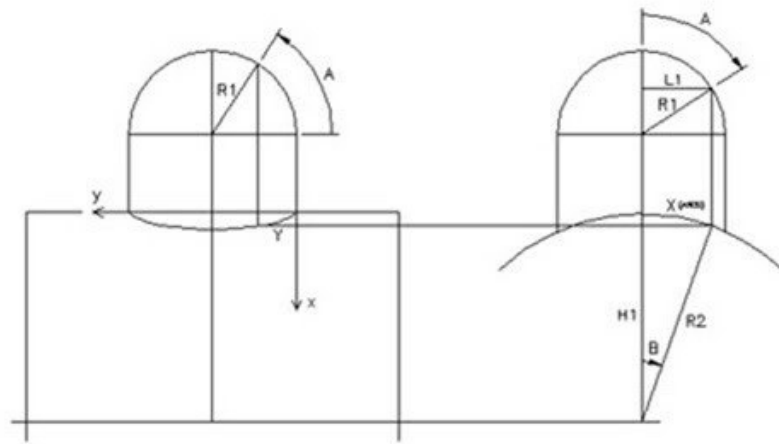
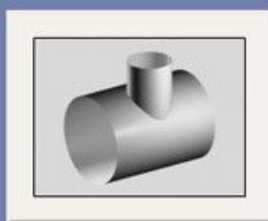
```
(DEFUN C:MSPICCHI ()
   (GRAPHSCR)
      (SETQ AG (GETREAL "\nIMMETTERE ANGOLO AG: ")
            R (GETREAL "\nIMMETTERE RAGGIO R: ")
            RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
            H (GETREAL "\nIMMETTERE ALTEZZA H: ")
            P1 (GETPOINT "\nPUNTO INIZIALE: ")
      )
         (SETQ P1 (LIST 0 0))
         (SETQ A (/ PI 90))
            (REPEAT 180
               (SETQ L (- R (* R (COS A)))
                     M (/ L (COS (* (/ PI 180) AG)))
                     Y (SQRT (- (* M M) (EXPT L 2)))
                     K (/ RN R)
                     X (* (* K R) A) P2 (LIST X Y)
               )
                  (COMMAND "LINE" P1 P2 "")
                  (SETQ P1 P2)
                  (SETQ A (+ A (/ PI 90)))
            )
                  (SETQ P3 (LIST (CAR P2) (- 0 H)))
                  (SETQ P4 (LIST 0 (- 0 H)))
                  (SETQ P5 (LIST 0 0))
                  (COMMAND "LINE" P2 P3 P4 P5 "")
                  (COMMAND "ZOOM" "ALL" "")
                  (PRINC)
)
```

OUTPUT
GRAPHIC CONSTRUCTION
AND FORMULAS
R
A
AG
L
M
Y
L = R − R x cosA
M = L/cosAG
Y = √M² − L²
X = R x A

PROGRAM: BOCCH.lsp

```
(DEFUN C:BOCCH ()
   (GRAPHSCR)
      (SETQ R1 (GETREAL "\nIMMETTERE RAGGIO R1: ")
            R2 (GETREAL "\nIMMETTERE RAGGIO R2: ")
            RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
            H (GETREAL "\nIMMETTERE ALTEZZA H: ")
            P1 (GETPOINT "\nPUNTO INIZIALE: ")
      )
         (SETQ P1 (LIST 0 0))
         (SETQ A (/ PI 90))
            (REPEAT 180
               (SETQ L1 (* R1 (SIN A))
                     H1 (SQRT (- (* R2 R2) (EXPT L1 2)))
                     Y (- R2 H1)
                     K (/ RN R1)
                     X (* (* K R1) A) P2 (LIST X Y)
               )
                  (COMMAND "LINE" P1 P2 "")
                  (SETQ P1 P2)
                  (SETQ A (+ A (/ PI 90)))
            )
                  (SETQ P3 (LIST (CAR P2) (- 0 H)))
                  (SETQ P4 (LIST 0 (- 0 H)))
                  (SETQ P5 (LIST 0 0))
                  (COMMAND "LINE" P2 P3 P4 P5 "")
                  (COMMAND "ZOOM" "ALL" "")
                  (COMMAND "UCS" "P")
                  (PRINC)
)
```

OUTPUT
GRAPHIC CONSTRUCTION AND FORMULAS
A
X
R1
Y
x
y
L1
R1
H1
R2
L1 = R1 x sinA
H1 = √R2² - L1²
X = R1 x A
Y = R2 - H1

PROGRAM: BOCH.lsp

```
(DEFUN C:BOCH ()
   (GRAPHSCR)
      (SETQ R1 (GETREAL "\nIMMETTERE RAGGIO R1: ")
            R2 (GETREAL "\nIMMETTERE RAGGIO R2: ")
            RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
            P1 (GETPOINT "\nPUNTO INIZIALE: ")
      )
         (SETQ P1 (LIST 0 0))
         (SETQ A (/ PI 90))
            (REPEAT 180
               (SETQ L1 (* R1 (SIN A))
                       H1 (SQRT (- (* R2 R2) (EXPT L1 2)))
                       B (ATAN (/ L1 H1))
                       Y (* R1 (- 1 (COS A)))
                       K (/ RN R2)
                       X (* (* K R2) B) P2 (LIST X Y)
               )
                  (COMMAND "LINE" P1 P2 "")
                  (SETQ P1 P2)
                  (SETQ A (+ A (/ PI 90)))
            )
                  (COMMAND "ZOOM" "ALL" "")
                  (PRINC)
)
```

OUTPUT
GRAPHIC CONSTRUCTION AND FORMULAS
R1
A
y
Y
x
L1
R1
A
X
H1
R2
B
L1 = R1 x sinA
H1 = √R2² − L1²
B = atan L1/H1
X = R2 x B
Y = R1 − (R1 x cosA)

PROGRAM: BOCC.lsp

```
(DEFUN C:BOCC ()
   (GRAPHSCR)
      (SETQ R1 (GETREAL "\nIMMETTERE RAGGIO R1: ")
            R2 (GETREAL "\nIMMETTERE RAGGIO R2: ")
            RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
            E (GETREAL "\nIMMETTERE ECCENTRICITA' E: ")
            H (GETREAL "\nIMMETTERE ALTEZZA H: ")
            P1 (GETPOINT "\nPUNTO INIZIALE: ")
      )
         (SETQ P1 (LIST 0 0))
         (SETQ A (/ PI 90))
            (REPEAT 180
               (SETQ L1 (+ (* R1 (SIN A)) E)
                     H0 (SQRT (- (* R2 R2) (EXPT E 2)))
                     H1 (SQRT (- (* R2 R2) (EXPT L1 2)))
                     Y (- H0 H1)
                     K (/ RN R1)
                     X (* (* K R1) A) P2 (LIST X Y)
               )
                  (COMMAND "LINE" P1 P2 "")
                  (SETQ P1 P2)
                  (SETQ A (+ A (/ PI 90)))
            )
                  (SETQ P3 (LIST (CAR P2) (- 0 H)))
                  (SETQ P4 (LIST 0 (- 0 H)))
                  (SETQ P5 (LIST 0 (CADR P2)))
                  (COMMAND "LINE" P2 P3 P4 P5 "")
                  (COMMAND "ZOOM" "ALL" "")
                  (PRINC)
)
```

OUTPUT
GRAPHIC CONSTRUCTION AND FORMULAS
A
X
R1
E
R2
L1
H0
H1
Y
x
y
X = R1 x A
H0 = √R2² − E²
L1 = E + R1 x sinA
H1 = √R2² − L1²
Y = H0 − H1

PROGRAM: BOC.lsp

```
(DEFUN C:BOC ()
   (GRAPHSCR)
      (SETQ R1 (GETREAL "\nIMMETTERE RAGGIO R1: ")
            R2 (GETREAL "\nIMMETTERE RAGGIO R2: ")
            RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
            E (GETREAL "\nIMMETTERE ECCENTRICITA' E: ")
            P1 (GETPOINT "\nIMMETTERE PUNTO INIZIALE : ")
      )
         (SETQ P1 (LIST 0 0))
         (SETQ A (/ PI 90))
            (REPEAT 180
               (SETQ L (* R1 (SIN A))
                     L1 (+ E L)
                     HO (SQRT (- (* R2 R2) (EXPT E 2)))
                     H (SQRT (- (* R2 R2) (EXPT L1 2)))
                     B1 (ATAN (/ L1 H))
                     BO (ATAN (/ E HO))
                     B (- B1 BO)
                     L2 (* R1 (COS A))
                     Y (- R1 L2)
                     K (/ RN R2)
                     X (* (* K R2) B) P2 (LIST X Y)

               )
                  (COMMAND "LINE" P1 P2 "")
                  (SETQ P1 P2)
                  (SETQ A (+ A (/ PI 90)))
            )
                  (COMMAND "ZOOM" "ALL" "")
                  (PRINC)
)
```

OUTPUT

GRAPHIC CONSTRUCTION AND FORMULAS

$L = R1 \times \sin A$

$L1 = E + L$

$H0 = \sqrt{R2^2 - E^2}$

$H = \sqrt{R2^2 - L1^2}$

$B1 = \operatorname{atan} L1/H$

$B0 = \operatorname{atan} E/H0$

$B = B1 - B0$

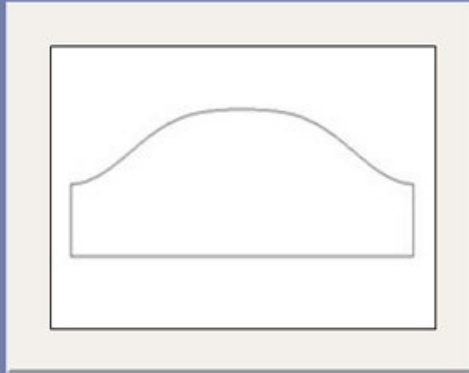
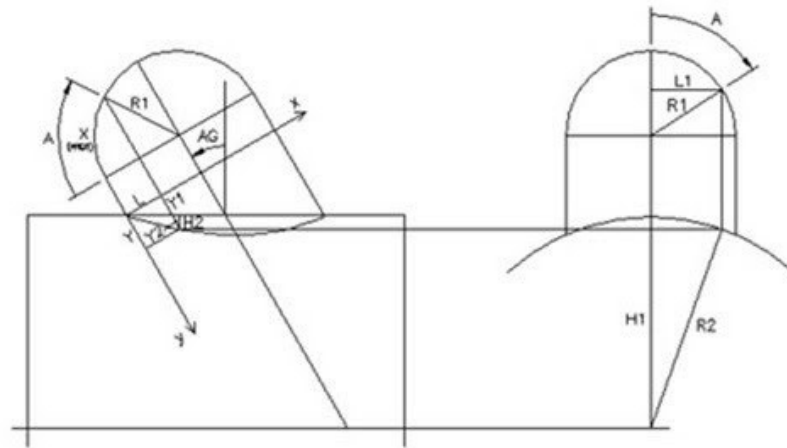
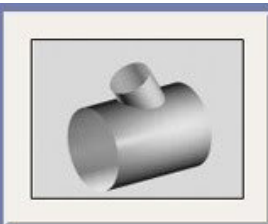
$X = R2 \times B$

$L2 = R1 \times \cos A$

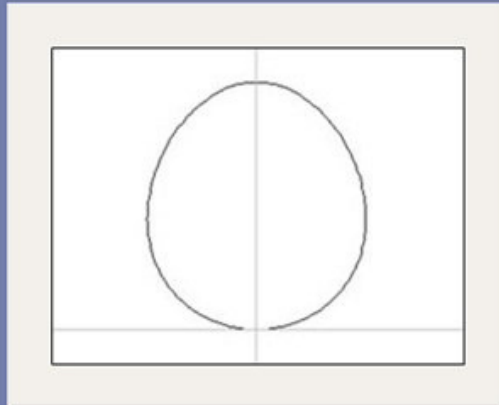
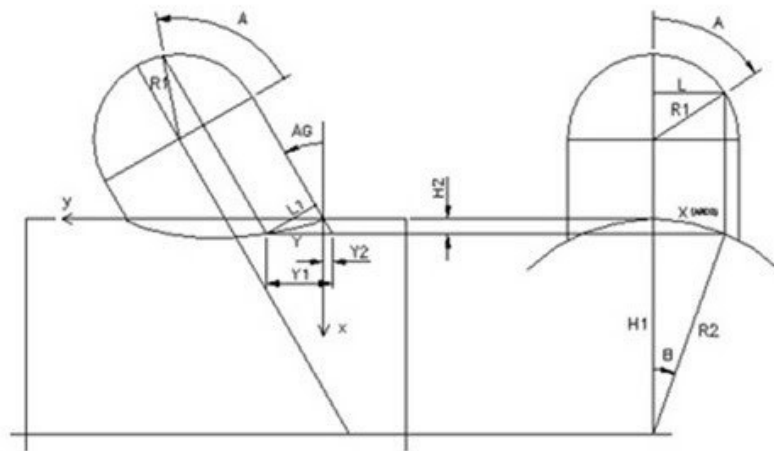
$Y = R1 - L2$

PROGRAM: BOCC1.lsp

```
(DEFUN C:BOCC1 ()
  (GRAPHSCR)
    (SETQ AG (GETREAL "\nIMMETTERE ANGOLO AG: ")
          R1 (GETREAL "\nIMMETTERE RAGGIO R1: ")
          RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
          R2 (GETREAL "\nIMMETTERE RAGGIO R2 : ")
          H (GETREAL "\nIMMETTERE ALTEZZA H: ")
          P1 (GETPOINT "\nPUNTO INIZIALE: ")
    )
      (SETQ P1 (LIST 0 0))
      (SETQ A (/ PI 90))
        (REPEAT 180
          (SETQ L (- R1 (* R1 (COS A)))
                Y1 (* L (/ (SIN (* (/ PI 180) AG)) (COS (* (/ PI 180) AG))))
                L1 (* R1 (SIN A))
                H1 (SQRT (- (* R2 R2) (EXPT L1 2)))
                H2 (- R2 H1)
                Y2 (/ H2 (COS (* (/ PI 180) AG)))
                Y (+ Y1 Y2)
                K (/ RN R1)
                X (* (* K R1) A) P2 (LIST X Y)
          )
            (COMMAND "LINE" P1 P2 "")
            (SETQ P1 P2)
            (SETQ A (+ A (/ PI 90)))
        )
            (SETQ P3 (LIST (CAR P2) (- 0 H)))
            (SETQ P4 (LIST 0 (- 0 H)))
            (SETQ P5 (LIST 0 0))
            (COMMAND "LINE" P2 P3 P4 P5 "")
            (COMMAND "ZOOM" "ALL" "")
            (COMMAND "UCS" "P")
            (PRINC)
)
```

OUTPUT
GRAPHIC CONSTRUCTION AND FORMULAS
A
L1
R1
R1
X
AG
L
Y1
Y
Y2
H2
H1
R2
X = R1 x A
L = R1 − R1 x cosA
Y1 = L x tanAG
L1 = R1 x sinA
H1 = √(R2² − L1²)
H2 = R2 − H1
Y2 = H2/cosAG
Y = Y1 + Y2

PROGRAM: BOC1.lsp

```
(DEFUN C:BOC1 ()
   (GRAPHSCR)
      (SETQ R1 (GETREAL "\nIMMETTERE RAGGIO R1: ")
            R2 (GETREAL "\nIMMETTERE RAGGIO R2: ")
            RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
            AG (GETREAL "\nIMMETTERE ANGOLO AG: ")
            P1 (GETPOINT "\nPUNTO INIZIALE: ")
      )
         (SETQ P1 (LIST 0 0))
         (SETQ A (/ PI 90))
            (REPEAT 180
               (SETQ L (* R1 (SIN A))
                       H1 (SQRT (- (* R2 R2) (EXPT L 2)))
                       B (ATAN (/ L H1))
                       H2 (- R2 H1)
                       L1 (* R1 (- 1 (COS A)))
                       Y1 (/ L1 (COS (* (/ PI 180) AG)))
                       Y2 (* H2 (/ (SIN (* (/ PI 180) AG)) (COS (* (/ PI 180) AG))))
                       Y (- Y1 Y2)
                       K (/ RN R2)
                       X (* (* K R2) B) P2 (LIST X Y)
               )
                  (COMMAND "LINE" P1 P2 "")
                  (SETQ P1 P2)
                  (SETQ A (+ A (/ PI 90)))
            )
                  (COMMAND "ZOOM" "ALL" "")
                  (PRINC)
)
```

OUTPUT

GRAPHIC CONSTRUCTION AND FORMULAS

$$L = R1 \times \sin A$$

$$H1 = \sqrt{R2^2 - L^2}$$

$$B = \operatorname{atan} L/H1$$

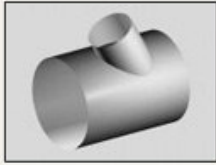
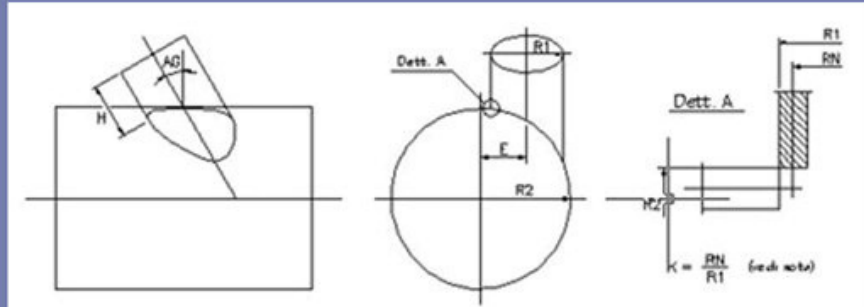
$$X = R2 \times B$$

$$L1 = R1 - (R1 \times \cos A)$$

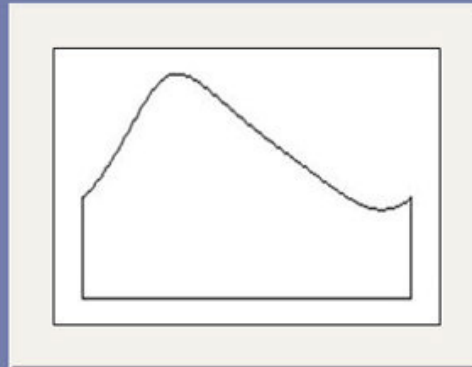
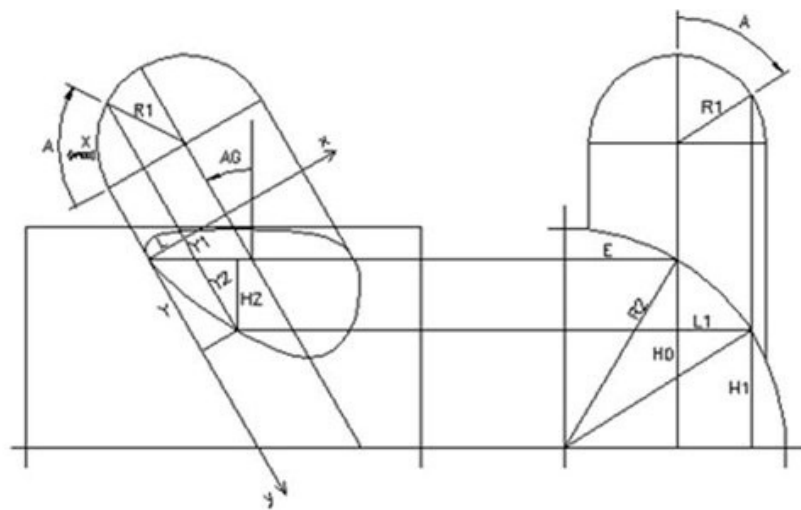
$$H2 = R2 - H1$$

$$Y2 = H2 \times \tan AG$$

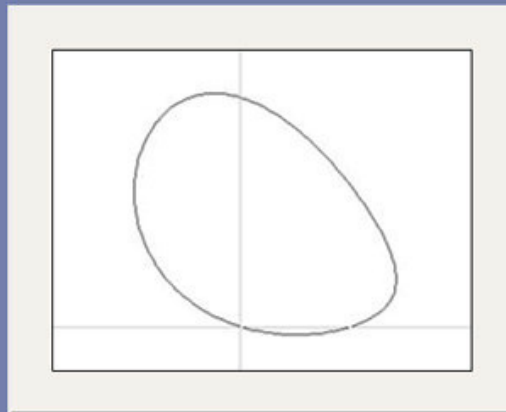
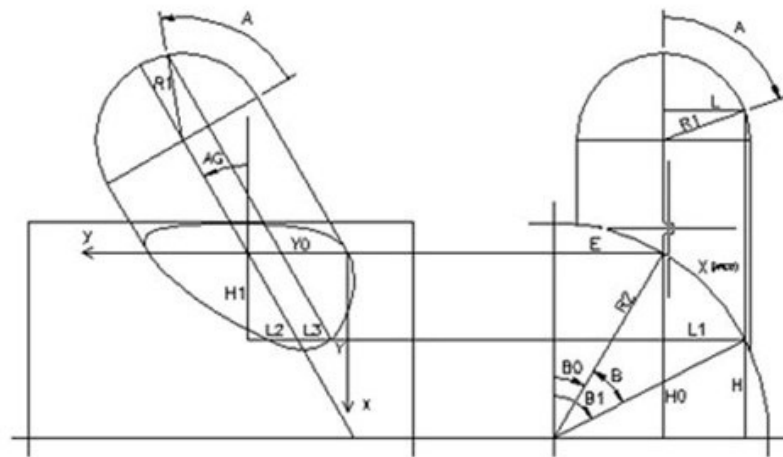
$$Y1 = L1/\cos AG$$

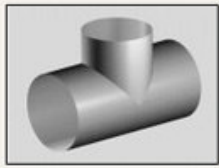
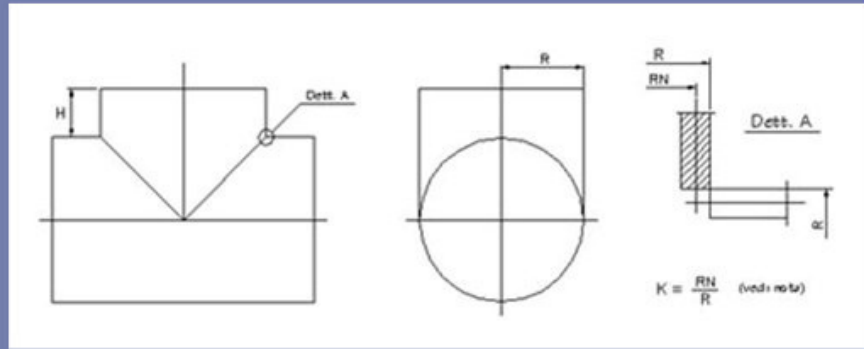
$$Y = Y1 - Y2$$

PROGRAM: BOCC2.lsp

```
(DEFUN C:BOCC2 ()
  (GRAPHSCR)
    (SETQ AG (GETREAL "\nIMMETTERE ANGOLO AG: ")
          R1 (GETREAL "\nIMMETTERE RAGGIO R1: ")
          RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
          R2 (GETREAL "\nIMMETTERE RAGGIO R2: ")
          E (GETREAL "\nIMMETTERE ECCENTRICITA' E: ")
          H (GETREAL "\nIMMETTERE ALTEZZA H: ")
          P1 (GETPOINT "\nPUNTO INIZIALE: ")
    )
      (SETQ P1 (LIST 0 0))
      (SETQ A (/ PI 90))
        (REPEAT 180
          (SETQ L (- R1 (* R1 (COS A)))
                Y1 (* L (/ (SIN (* (/ PI 180) AG)) (COS (* (/ PI 180) AG))))
                H0 (SQRT (- (* R2 R2) (EXPT E 2)))
                L1 (+ E (* R1 (SIN A)))
                H1 (SQRT (- (* R2 R2) (* L1 L1)))
                H2 (- H0 H1)
                Y2 (/ H2 (COS (* (/ PI 180) AG)))
                Y (+ Y1 Y2)
                K (/ RN R1)
                X (* (* K R1) A) P2 (LIST X Y)
          )
            (COMMAND "LINE" P1 P2 "")
            (SETQ P1 P2)
            (SETQ A (+ A (/ PI 90)))
        )
            (SETQ P3 (LIST (CAR P2) (- 0 H)))
            (SETQ P4 (LIST 0 (- 0 H)))
            (SETQ P5 (LIST 0 (CADR P2)))
            (COMMAND "LINE" P2 P3 P4 P5 "")
            (COMMAND "ZOOM" "ALL" "")
            (PRINC)
)
```

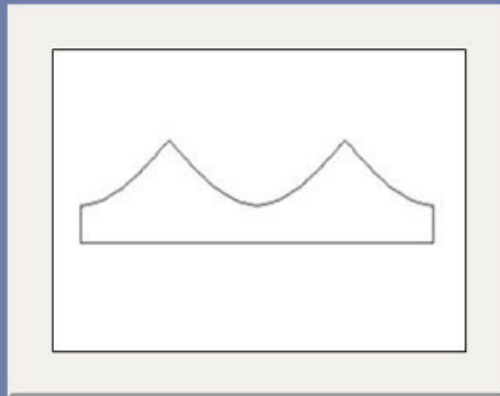
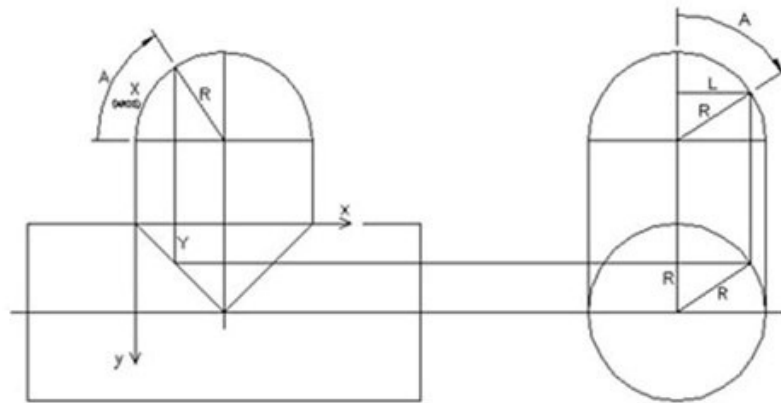
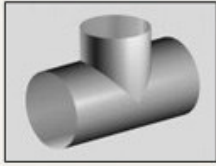
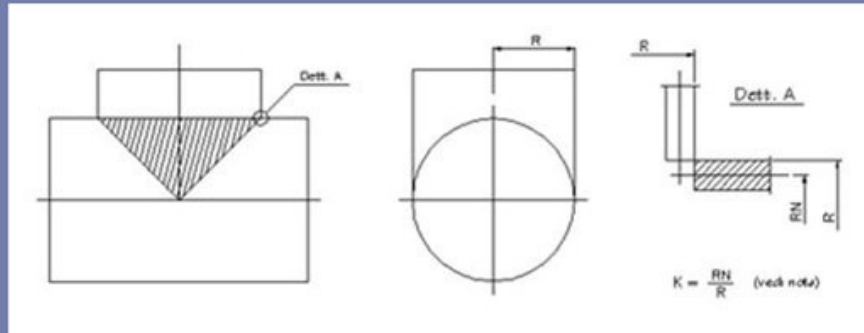
OUTPUT
GRAPHIC CONSTRUCTION AND FORMULAS
X = R1 x A
L = R1 − R1 x cosA
Y1 = L x tanAG
H0 = √R2² − E²
L1 = E + R1 x sinA
H1 = √R2² − L1²
H2 = H0 − H1
Y2 = H2/cosAG
Y = Y1 + Y2

PROGRAM: BOC2.lsp

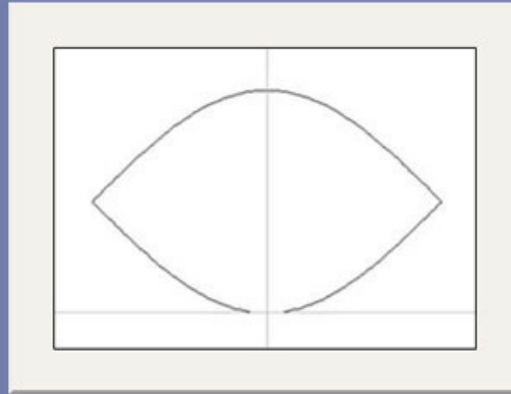
```
(DEFUN C:BOC2 ()
  (GRAPHSCR)
    (SETQ R1 (GETREAL "\nIMMETTERE RAGGIO R1: ")
          R2 (GETREAL "\nIMMETTERE RAGGIO R2: ")
          RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
          AG (GETREAL "\nIMMETTERE ANGOLO AG: ")
          E (GETREAL "\nIMMETTERE ECCENTRICITA' E: ")
          P1 (GETPOINT "\nIMMETTERE PUNTO INIZIALE : ")
    )
      (SETQ P1 (LIST 0 0))
      (SETQ A (/ PI 90))
        (REPEAT 180
          (SETQ L (* R1 (SIN A))
                L1 (+ E L)
                HO (SQRT (- (* R2 R2) (EXPT E 2)))
                H (SQRT (- (* R2 R2) (EXPT L1 2)))
                B1 (ATAN (/ L1 H))
                BO (ATAN (/ E HO))
                B (- B1 BO)
                YO (/ R1 (COS (* (/ PI 180) AG)))
                H1 (- HO H)
                L2 (* H1 (/ (SIN (* (/ PI 180) AG)) (COS (* (/ PI 180) AG))))
                L3 (* (/ R1 (COS (* (/ PI 180) AG))) (COS A))
                Y (- YO (+ L2 L3))
                K (/ RN R2)
                X (* (* K R2) B) P2 (LIST X Y)

          )
            (COMMAND "LINE" P1 P2 "")
            (SETQ P1 P2)
            (SETQ A (+ A (/ PI 90)))
        )
            (COMMAND "ZOOM" "ALL" "")
            (PRINC)
)
```

OUTPUT

GRAPHIC CONSTRUCTION
AND FORMULAS

L	=	$R1 \times \sin A$
L1	=	$E + L$
H0	=	$\sqrt{R2^2 - E^2}$
H	=	$\sqrt{R2^2 - L1^2}$
B1	=	$\operatorname{atan} L1/H$
B0	=	$\operatorname{atan} E/H0$
B	=	$B1 - B0$
X	=	$R2 \times B$

Y0	=	$R1/\cos AG$
H1	=	$H0 - H$
L2	=	$H1 \times \tan AG$
L3	=	$R1 \times \cos A/\cos AG$
Y	=	$Y0 - (L2+L3)$

PROGRAM: TEE.lsp

```
(DEFUN C:TEE ()
  (GRAPHSCR)
    (SETQ R (GETREAL "\nIMMETTERE RAGGIO R: ")
          RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
          H (GETREAL "\nIMMETTERE ALTEZZA H: ")
          P1 (GETPOINT "\nPUNTO INIZIALE: ")
    )
      (SETQ P1 (LIST 0 0))
      (SETQ A (/ PI 90))
        (REPEAT 180
          (SETQ L (* R (SIN A))
                Y (- R (SQRT (- (* R R) (EXPT L 2))))
                K (/ RN R)
                X (* (* K R) A) P2 (LIST X Y)
          )
            (COMMAND "LINE" P1 P2 "")
            (SETQ P1 P2)
            (SETQ A (+ A (/ PI 90)))
        )
            (SETQ P3 (LIST (CAR P2) (- 0 H)))
            (SETQ P4 (LIST 0 (- 0 H)))
            (SETQ P5 (LIST 0 0))
            (COMMAND "LINE" P2 P3 P4 P5 "")
            (COMMAND "ZOOM" "ALL" "")
            (PRINC)
)
```

OUTPUT
GRAPHIC CONSTRUCTION AND FORMULAS
A
X
R
Y
x
y
L
X = R x A
L = R x sinA
Y = R − √R² − L²

PROGRAM: TEE1.lsp

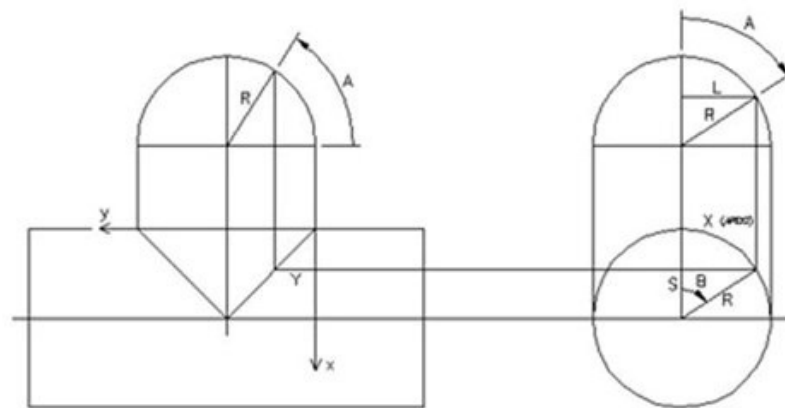
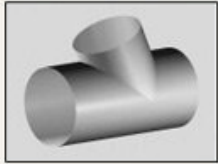
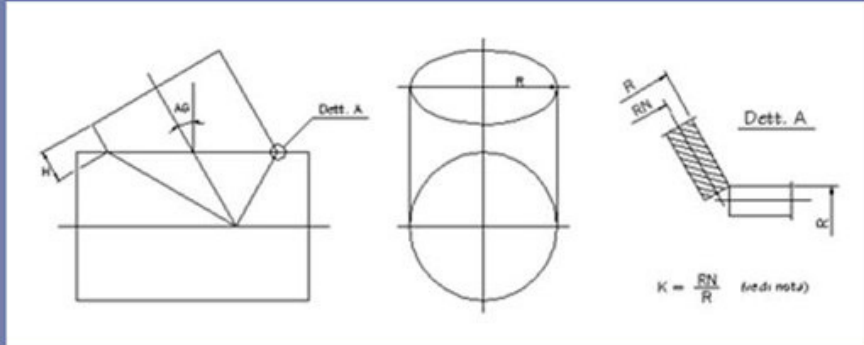
```
(DEFUN C:TEE1 ()
  (GRAPHSCR)
    (SETQ R (GETREAL "\nIMMETTERE RAGGIO R: ")
          RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
          P1 (GETPOINT "\nPUNTO INIZIALE: ")
    )
      (SETQ P1 (LIST 0 0))
      (SETQ A (/ PI 90))
        (REPEAT 180
          (SETQ L (* R (SIN A))
                S (SQRT (- (* (* R R) 1.00000001) (EXPT L 2)))
                B (ATAN (/ L S))
                Y (* R (- 1 (COS A)))
                K (/ RN R)
                X (* (* K R) B) P2 (LIST X Y)
          )
            (COMMAND "LINE" P1 P2 "")
            (SETQ P1 P2)
            (SETQ A (+ A (/ PI 90)))
        )
            (COMMAND "ZOOM" "ALL" "")
            (PRINC)
)
```

OUTPUT

GRAPHIC CONSTRUCTION AND FORMULAS

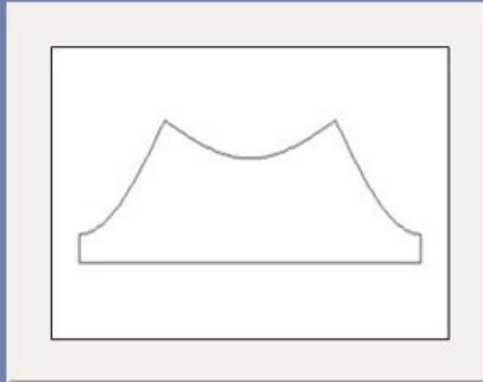
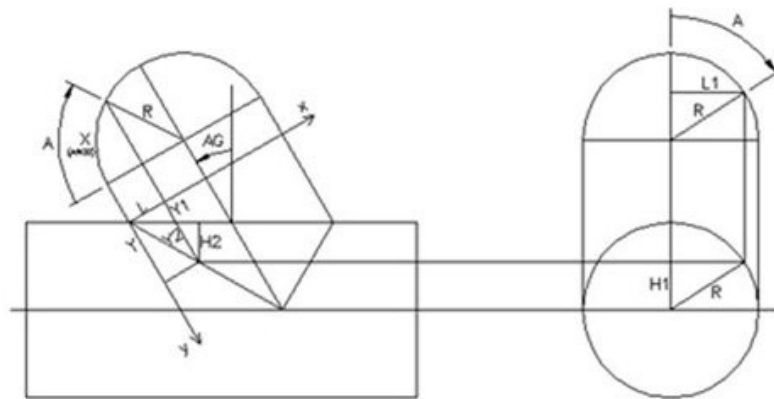
$L = R \times \sin A$

$S = \sqrt{R^2 - L^2}$

$B = \operatorname{atan} L/S$

$X = R \times B$

$Y = R - (R \times \cos A)$

PROGRAM: TEE2.lsp

```
(DEFUN C:TEE2 ()
  (GRAPHSCR)
    (SETQ AG (GETREAL "\nIMMETTERE ANGOLO AG: ")
          R (GETREAL "\nIMMETTERE RAGGIO R: ")
          RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
          H (GETREAL "\nIMMETTERE ALTEZZA H: ")
          P1 (GETPOINT "\nPUNTO INIZIALE: ")
    )
      (SETQ P1 (LIST 0 0))
      (SETQ A (/ PI 90))
        (REPEAT 180
          (SETQ L (- R (* R (COS A)))
                Y1 (* L (/ (SIN (* (/ PI 180) AG)) (COS (* (/ PI 180) AG))))
                L1 (* R (SIN A))
                Y2 (/ (- R (SQRT (- (* R R) (EXPT L1 2)))) (COS (* (/ PI 180) AG)))
                Y (+ Y1 Y2)
                K (/ RN R)
                X (* (* K R) A) P2 (LIST X Y)
          )
            (COMMAND "LINE" P1 P2 "")
            (SETQ P1 P2)
            (SETQ A (+ A (/ PI 90)))
        )
            (SETQ P3 (LIST (CAR P2) (- 0 H)))
            (SETQ P4 (LIST 0 (- 0 H)))
            (SETQ P5 (LIST 0 0))
            (COMMAND "LINE" P2 P3 P4 P5 "")
            (COMMAND "ZOOM" "ALL" "")
            (PRINC)
)
```

OUTPUT
GRAPHIC CONSTRUCTION
AND FORMULAS
A
X
AG
R
L1
H1
H2
Y1
Y2
Y
X = R x A
L = R − R x cosA
Y1 = L x tanAG
L1 = R x sinA
H1 = √R² − L1²
H2 = R − H1
Y2 = H2/cosAG
Y = Y1 + Y2

PROGRAM: TEE3.lsp

```
(DEFUN C:TEE3 ()
   (GRAPHSCR)
      (SETQ R (GETREAL "\nIMMETTERE RAGGIO R: ")
            RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
            AG (GETREAL "\nIMMETTERE ANGOLO AG: ")
            P1 (GETPOINT "\nPUNTO INIZIALE: ")
      )
         (SETQ P1 (LIST 0 0))
         (SETQ A (/ PI 90))
            (REPEAT 180
               (SETQ L (* R (SIN A))
                     H1 (SQRT (- (* (* R R) 1.000000001) (EXPT L 2)))
                     B (ATAN (/ L H1))
                     H2 (- R H1)
                     L1 (* R (- 1 (COS A)))
                     Y1 (/ L1 (COS (* (/ PI 180) AG)))
                     Y2 (* H2 (/ (SIN (* (/ PI 180) AG)) (COS (* (/ PI 180) AG))))
                     Y (- Y1 Y2)
                     K (/ RN R)
                     X (* (* K R) B) P2 (LIST X Y)
               )
                  (COMMAND "LINE" P1 P2 "")
                  (SETQ P1 P2)
                  (SETQ A (+ A (/ PI 90)))
            )
                  (COMMAND "ZOOM" "ALL" "")
                  (PRINC)
)
```

OUTPUT

GRAPHIC CONSTRUCTION AND FORMULAS

$$L = R \times \sin A$$

$$H1 = \sqrt{R^2 - L^2}$$

$$B = \operatorname{atan} L/H1$$

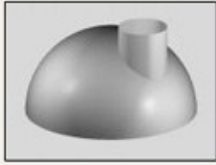
$$X = R \times B$$

$$L1 = R - (R \times \cos A)$$

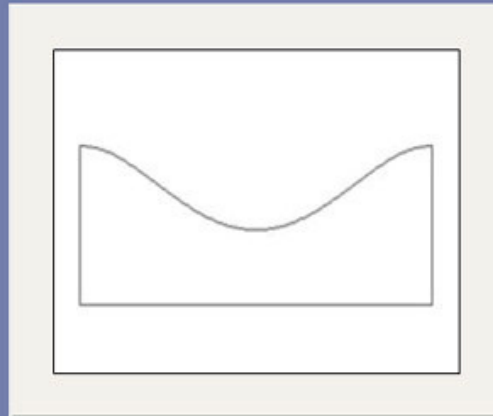
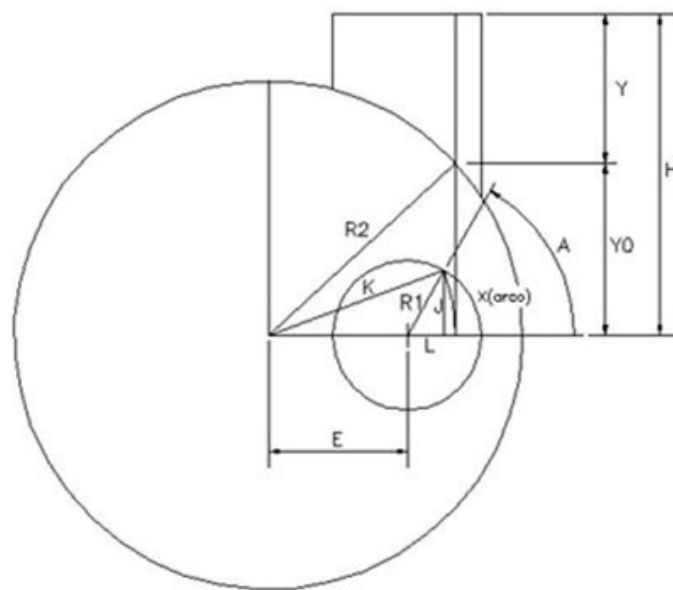
$$H2 = R - H1$$

$$Y2 = H2 \times \tan AG$$

$$Y1 = L1/\cos AG$$

$$Y = Y1 - Y2$$

PROGRAM: CILSF.lsp

```
(DEFUN C:CILSF ()
   (GRAPHSCR)
      (SETQ R1 (GETREAL "\nIMMETTERE RAGGIO R1: ")
            RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
            R2 (GETREAL "\nIMMETTERE RAGGIO R2: ")
            E (GETREAL "\nIMMETTERE ECCENTRICITA' E: ")
            H (GETREAL "\nIMMETTERE ALTEZZA H: ")
            P1 (GETPOINT "\nPUNTO INIZIALE: ")
      )
         (SETQ HO (- H (SQRT (- (* R2 R2) (EXPT (+ E R1) 2)))))
         (SETQ P1 (LIST 0 HO))
         (SETQ A (/ PI 90))
            (REPEAT 180
               (SETQ J (* R1 (SIN A))
                     L (* R1 (COS A))
                     K (SQRT (+ (EXPT (+ E L) 2) (EXPT J 2)))
                     YO (SQRT (- (* R2 R2) (EXPT K 2)))
                     Y  (- H YO)
                     K1 (/ RN R1)
                     X (* (* K1 R1) A) P2 (LIST X Y)
               )
                  (COMMAND "LINE" P1 P2 "")
                  (SETQ P1 P2)
                  (SETQ A (+ A (/ PI 90)))
            )
                  (SETQ P3 (LIST (CAR P2) 0))
                  (SETQ P4 (LIST 0 0))
                  (SETQ P5 (LIST 0 (CADR P2)))
                  (COMMAND "LINE" P2 P3 P4 P5 "")
                  (COMMAND "ZOOM" "ALL" "")
                  (PRINC)
)
```

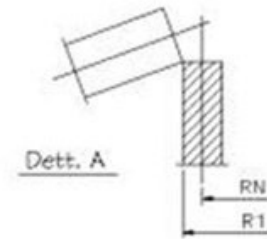
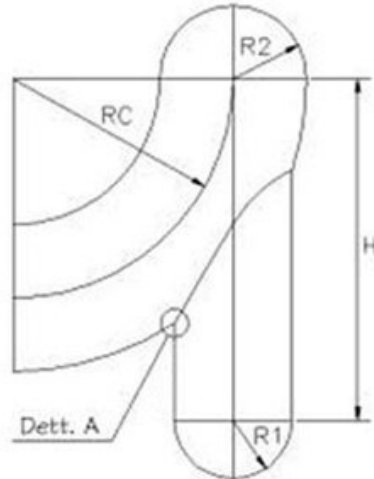
OUTPUT

GRAPHIC CONSTRUCTION AND FORMULAS

$X = R1 \times A$

$J = R1 \times \sin A$

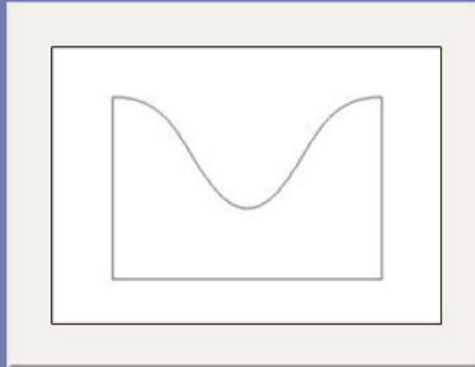
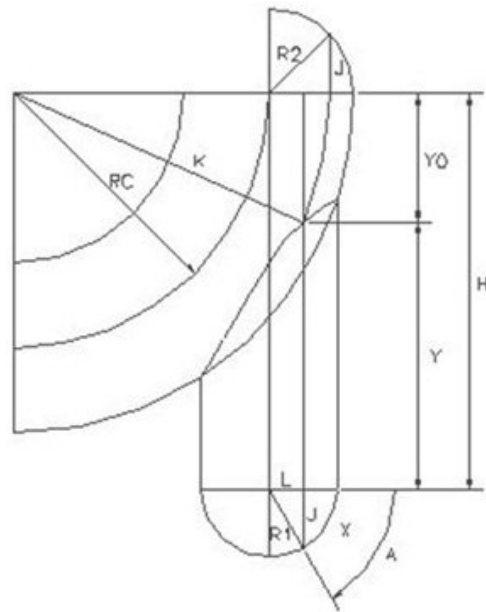
$L = R1 \times \cos A$

$K = \sqrt{(E + L)^2 + J^2}$

$Y0 = \sqrt{R2^2 - K^2}$

$Y = H - Y0$

PROGRAM: CILTO.lsp

```
(DEFUN C:CILTO ()
  (GRAPHSCR)
    (SETQ RC (GETREAL "\nIMMETTERE RAGGIO RC: ")
        R1 (GETREAL "\nIMMETTERE RAGGIO R1: ")
        RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
        R2 (GETREAL "\nIMMETTERE RAGGIO R2: ")
        H (GETREAL "\nIMMETTERE ALTEZZA H: ")
        P1 (GETPOINT "\nPUNTO INIZIALE: ")
    )
      (SETQ HO (- H (SQRT (- (* (+ RC R2) (+ RC R2)) (EXPT (+ RC R1) 2)))))
      (SETQ P1 (LIST O HO))
      (SETQ A (/ PI 90))
        (REPEAT 180
          (SETQ J (* R1 (SIN A))
               L (* R1 (COS A))
               K (+ RC (SQRT (- (* R2 R2) (EXPT J 2))))
               YO (SQRT (- (* K K) (EXPT (+ RC L) 2)))
               Y (- H YO)
               K (/ RN R1)
               X (* (* K R1) A) P2 (LIST X Y)
          )
            (COMMAND "LINE" P1 P2 "")
            (SETQ P1 P2)
            (SETQ A (+ A (/ PI 90)))
        )
            (SETQ P3 (LIST (CAR P2) O))
            (SETQ P4 (LIST O O))
            (SETQ P5 (LIST O (CADR P2)))
            (COMMAND "LINE" P2 P3 P4 P5 "")
            (COMMAND "ZOOM" "ALL" "")
            (PRINC)
)
```

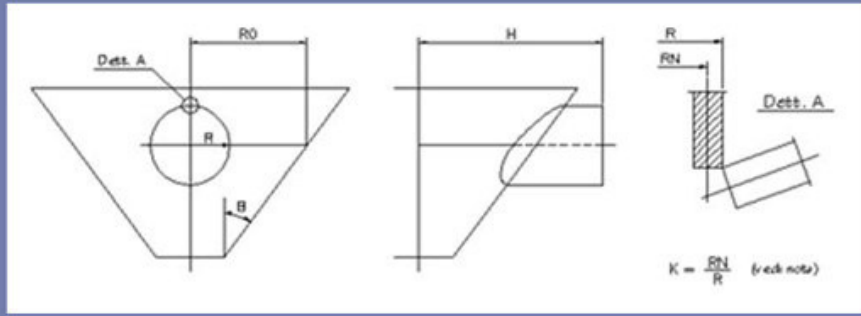
OUTPUT

GRAPHIC CONSTRUCTION AND FORMULAS

$$J = R1 \times \sin A$$

$$K = RC + \sqrt{R2^2 - J^2}$$

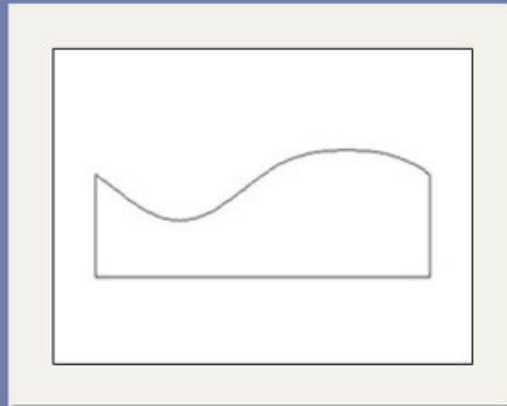
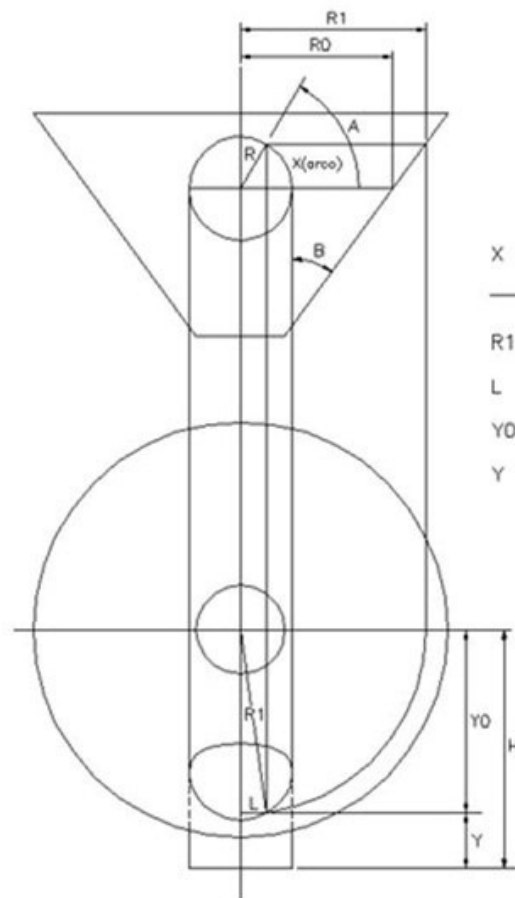
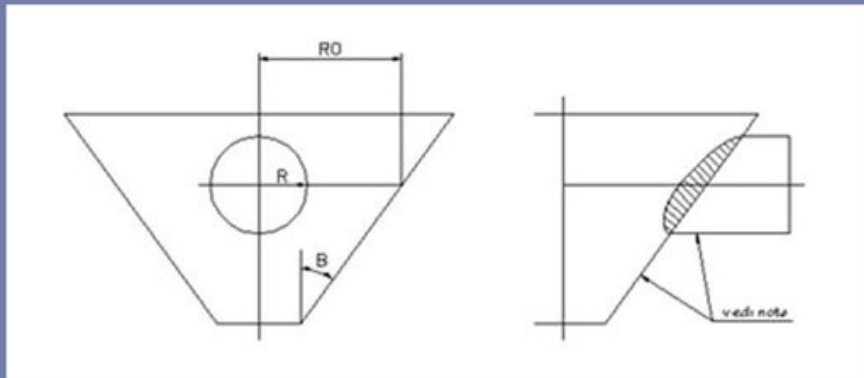
$$L = R1 \times \cos A$$

$$Y0 = \sqrt{K^2 - (RC + L)^2}$$

$$X = R1 \times A$$

$$Y = H - Y0$$

PROGRAM: CILCO.lsp

```
(DEFUN C:CILCO ()
   (GRAPHSCR)
      (SETQ R (GETREAL "\nIMMETTERE RAGGIO R: ")
            RO (GETREAL "\nIMMETTERE RAGGIO RO: ")
            RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
            B (GETREAL "\nIMMETTERE ANGOLO B: ")
            H (GETREAL "\nIMMETTERE ALTEZZA H: ")
            P1 (GETPOINT "\nPUNTO INIZIALE: ")
      )
         (SETQ HO (- H (SQRT (- (* RO RO) (EXPT R 2)))))
         (SETQ P1 (LIST O HO))
         (SETQ A (/ PI 90))
            (REPEAT 180
               (SETQ R1 (+ RO (* (* R (SIN A)) (/ (SIN (* (/ PI 180) B)) (COS (* (/ PI 180) B)))))
                     L (* R (COS A))
                     YO (SQRT (- (* R1 R1) (EXPT L 2)))
                     Y (- H YO)
                     K (/ RN R)
                     X (* (* K R) A) P2 (LIST X Y)
               )
                  (COMMAND "LINE" P1 P2 "")
                  (SETQ P1 P2)
                  (SETQ A (+ A (/ PI 90)))
            )
                  (SETQ P3 (LIST (CAR P2) O))
                  (SETQ P4 (LIST O O))
                  (SETQ P5 (LIST O (CADR P2)))
                  (COMMAND "LINE" P2 P3 P4 P5 "")
                  (COMMAND "ZOOM" "ALL" "")
                  (PRINC)
)
```

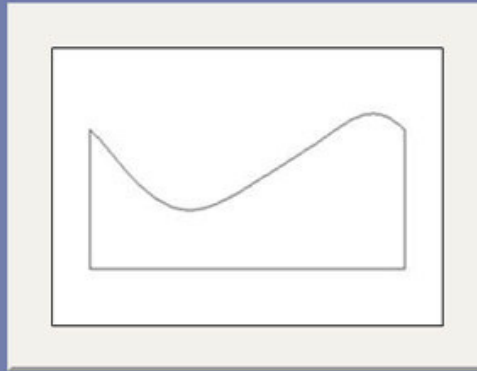
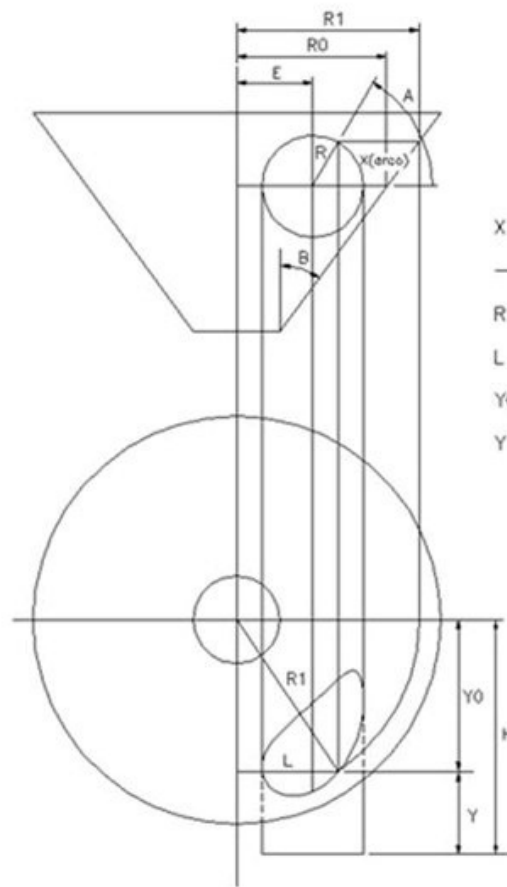
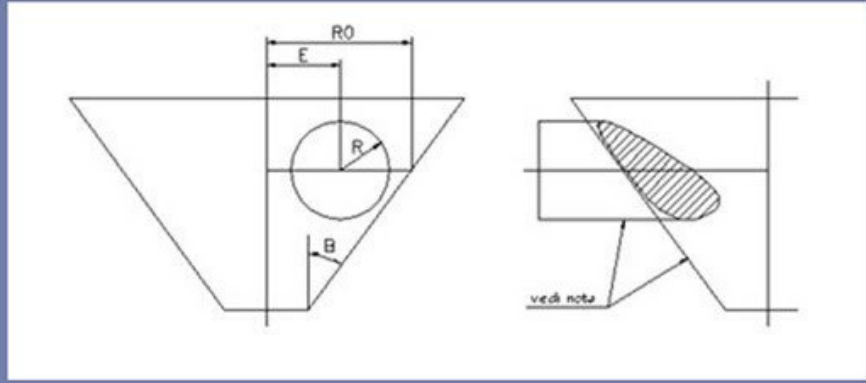
OUTPUT
GRAPHIC CONSTRUCTION
AND FORMULAS
R1
R0
A
R
X(arco)
B
X = R x A
R1 = R0 + R x sinA x tanB
L = R x cosA
Y0 = √R1² − L²
Y = H − Y0
R1
L
Y0
H
Y

PROGRAM: CICON.lsp

```
(DEFUN C:CICON ()
   (GRAPHSCR)
      (SETQ R (GETREAL "\nIMMETTERE RAGGIO R: ")
            RO (GETREAL "\nIMMETTERE RAGGIO RO: ")
            B (GETREAL "\nIMMETTERE ANGOLO B: ")
            P1 (GETPOINT "\nPUNTO INIZIALE: ")
      )
         (SETQ PO (LIST 0 0))
         (SETQ A 0)
         (SETQ L (* R (COS A)))
         (SETQ R1 (+ RO (* (* R (SIN A)) (/ (SIN (* (/ PI 180) B)) (COS (* (/ PI 180) B))))))
         (SETQ V1 (/ R1 (SIN (* (/ PI 180) B))))
         (SETQ H (SQRT (- (* R1 R1) (EXPT L 2))))
         (SETQ Q (ATAN (/ L H)))
         (SETQ Q1 (/ (* Q R1) V1))
         (SETQ P1 (POLAR PO Q1 V1))
         (SETQ A (/ PI 90))
            (REPEAT 180
               (SETQ L (* R (COS A))
                     R1 (+ RO (* (* R (SIN A)) (/ (SIN (* (/ PI 180) B)) (COS (* (/ PI 180) B)))))
                     V1 (/ R1 (SIN (* (/ PI 180) B)))
                     H (SQRT (- (* R1 R1) (EXPT L 2)))
                     Q (ATAN (/ L H))
                     Q1 (/ (* Q R1) V1)
                     P2 (POLAR PO Q1 V1)
               )
                  (COMMAND "LINE" P1 P2 "")
                  (SETQ P1 P2)
                  (SETQ A (+ A (/ PI 90)))
            )
                  (COMMAND "ROTATE" "ALL" "" PO 90 "")
                  (COMMAND "ZOOM" "ALL" "")
                  (PRINC)
)
```

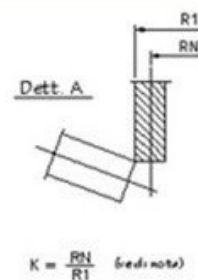
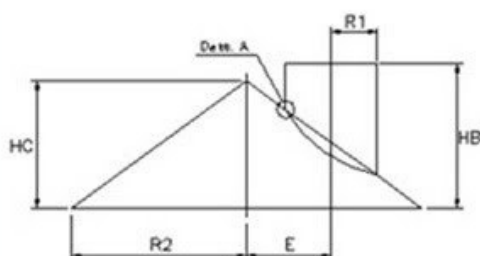
OUTPUT
GRAPHIC CONSTRUCTION AND FORMULAS
R1
R0
A
P1
R
B
V1
P0
R1
H
L
Q
L = R x cosA
R1 = R0 + R x sinA x tanB
V1 = R1 / sinB
H = √R1² − L²
Q = atan (L / H)
Q1 = (Q x R1) / V1
P1 (POLAR P0 Q1 V1)

PROGRAM: CILCOE.lsp

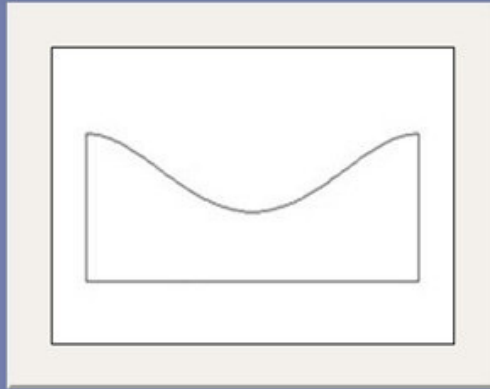
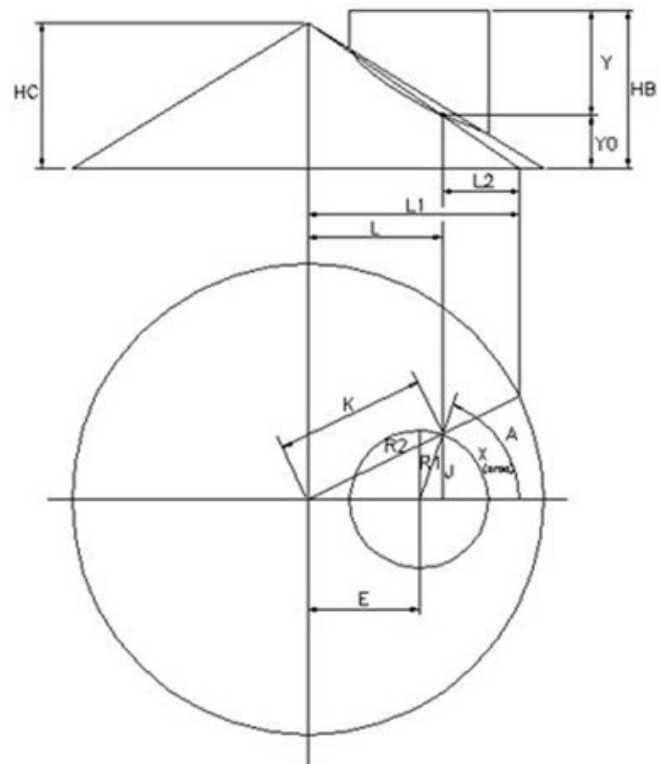
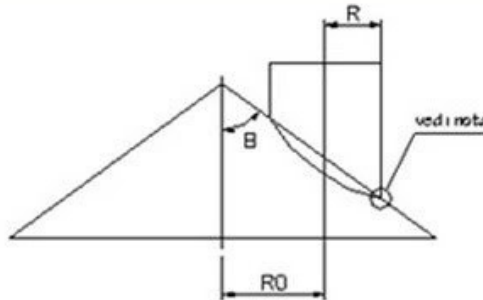
```
(DEFUN C:CILCOE ()
  (GRAPHSCR)
    (SETQ R (GETREAL "\nIMMETTERE RAGGIO R: ")
          RO (GETREAL "\nIMMETTERE RAGGIO RO: ")
          RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
          B (GETREAL "\nIMMETTERE ANGOLO B: ")
          E (GETREAL "\nIMMETTERE ECCENTRICITA' E: ")
          H (GETREAL "\nIMMETTERE ALTEZZA H: ")
          P1 (GETPOINT "\nPUNTO INIZIALE: ")
    )
      (SETQ HO (- H (SQRT (- (* RO RO) (EXPT (+ E R) 2)))))
      (SETQ P1 (LIST 0 HO))
      (SETQ A (/ PI 90))
        (REPEAT 180
          (SETQ R1 (+ RO (* (* R (SIN A)) (/ (SIN (* (/ PI 180) B)) (COS (* (/ PI 180) B)))))
                L (+ E (* R (COS A)))
                YO (SQRT (- (* R1 R1) (EXPT L 2)))
                Y (- H YO)
                K (/ RN R)
                X (* (* K R) A) P2 (LIST X Y)
          )
            (COMMAND "LINE" P1 P2 "")
            (SETQ P1 P2)
            (SETQ A (+ A (/ PI 90)))
        )
            (SETQ P3 (LIST (CAR P2) 0))
            (SETQ P4 (LIST 0 0))
            (SETQ P5 (LIST 0 (CADR P2)))
            (COMMAND "LINE" P2 P3 P4 P5 "")
            (COMMAND "ZOOM" "ALL" "")
            (PRINC)
)
```

OUTPUT
GRAPHIC CONSTRUCTION AND FORMULAS
R1
R0
E
A
R
X(arco)
B
X = R x A
R1 = R0 + R x sinA x tanB
L = E + R x cosA
Y0 = √R1² − L²
Y = H − Y0
R1
Y0
H
L
Y

PROGRAM: CICONE.lsp

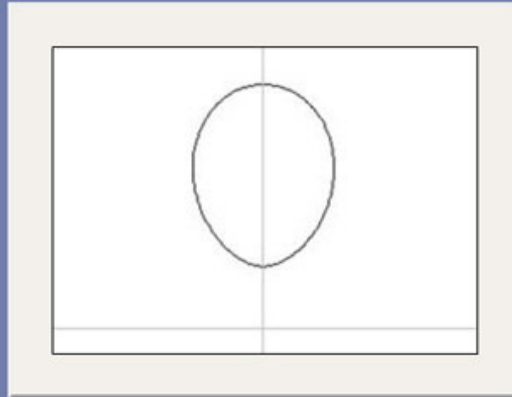
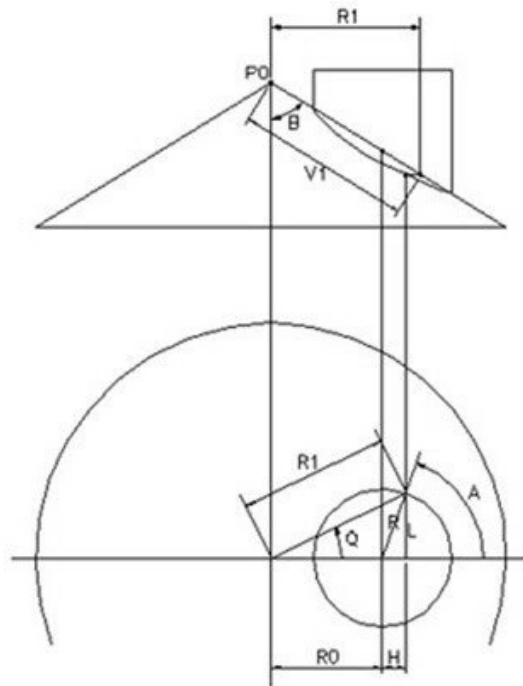
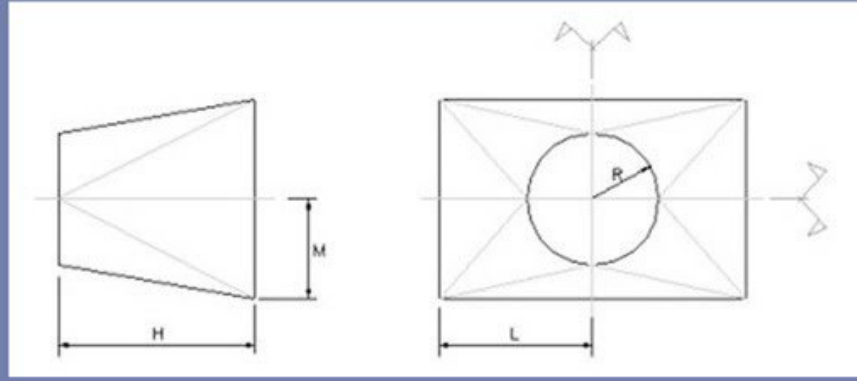
```
(DEFUN C:CICONE ()
   (GRAPHSCR)
      (SETQ R (GETREAL "\nIMMETTERE RAGGIO R: ")
            RO (GETREAL "\nIMMETTERE RAGGIO RO: ")
            B (GETREAL "\nIMMETTERE ANGOLO B: ")
            E (GETREAL "\nIMMETTERE ECCENTRICITA' E: ")
            P1 (GETPOINT "\nPUNTO INIZIALE: ")
      )
         (SETQ PO (LIST 0 0))
         (SETQ A 0)
         (SETQ L (+ E (* R (COS A))))
         (SETQ R1 (+ RO (* (* R (SIN A)) (/ (SIN (* (/ PI 180) B)) (COS (* (/ PI 180) B))))))
         (SETQ V1 (/ R1 (SIN (* (/ PI 180) B))))
         (SETQ H (SQRT (- (* R1 R1) (EXPT L 2))))
         (SETQ Q (ATAN (/ L H)))
         (SETQ Q1 (/ (* Q R1) V1))
         (SETQ P1 (POLAR PO Q1 V1))
         (SETQ A (/ PI 90))
            (REPEAT 180
               (SETQ L (+ E (* R (COS A)))
                     R1 (+ RO (* (* R (SIN A)) (/ (SIN (* (/ PI 180) B)) (COS (* (/ PI 180) B)))))
                     V1 (/ R1 (SIN (* (/ PI 180) B)))
                     H (SQRT (- (* R1 R1) (EXPT L 2)))
                     Q (ATAN (/ L H))
                     Q1 (/ (* Q R1) V1)
                     P2 (POLAR PO Q1 V1)
               )
                  (COMMAND "LINE" P1 P2 "")
                  (SETQ P1 P2)
                  (SETQ A (+ A (/ PI 90)))
            )
                  (COMMAND "ROTATE" "ALL" "" PO 90 "")
                  (COMMAND "ZOOM" "ALL" "")
                  (PRINC)
)
```

OUTPUT
GRAPHIC CONSTRUCTION AND FORMULAS
R1
R0
E
A
P1
R
B
V1
P0
x
Q
R1
L
H
L = E + R x cosA
R1 = R0 + R x sinA x tanB
V1 = R1 / sinB
H = √R1² − L²
Q = atan (L / H)
Q1 = (Q x R1) / V1
P1 (POLAR P0 Q1 V1)

PROGRAM: CILCOP.lsp

```
(DEFUN C:CILCOP ()
  (GRAPHSCR)
    (SETQ R1 (GETREAL "\nIMMETTERE RAGGIO R1: ")
          RN (GETREAL "\nIMMETTERE RAGGIO RN: ")
          R2 (GETREAL "\nIMMETTERE RAGGIO R2: ")
          E (GETREAL "\nIMMETTERE ECCENTRICITA' E: ")
          HC (GETREAL "\nIMMETTERE ALTEZZA HC: ")
          HB (GETREAL "\nIMMETTERE ALTEZZA HB: ")
          P1 (GETPOINT "\nPUNTO INIZIALE: ")
    )
      (SETQ LO (- R2 (+ E R1)))
      (SETQ H (/ (* HC LO) R2))
      (SETQ HO (- HB H))
      (SETQ P1 (LIST 0 HO))
      (SETQ A (/ PI 90))
        (REPEAT 180
          (SETQ J (* R1 (SIN A))
                L (+ E (* R1 (COS A)))
                K (SQRT (+ (EXPT L 2) (EXPT J 2)))
                L1 (/ (* L R2) K)
                L2 (- L1 L)
                YO (/ (* HC L2) L1)
                Y  (- HB YO)
                K1 (/ RN R1)
                X (* (* K1 R1) A) P2 (LIST X Y)
          )
            (COMMAND "LINE" P1 P2 "")
            (SETQ P1 P2)
            (SETQ A (+ A (/ PI 90)))
        )
            (SETQ P3 (LIST (CAR P2) 0))
            (SETQ P4 (LIST 0 0))
            (SETQ P5 (LIST 0 (CADR P2)))
            (COMMAND "LINE" P2 P3 P4 P5 "")
            (COMMAND "ZOOM" "ALL" "")
            (PRINC)
)
```

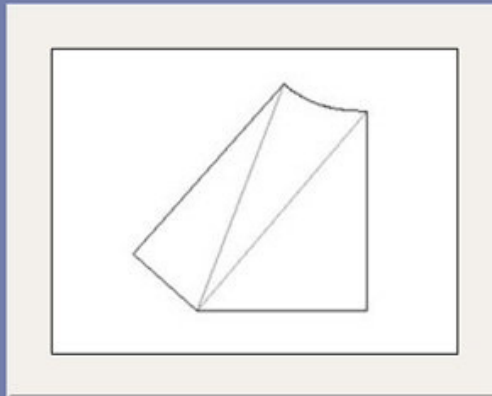
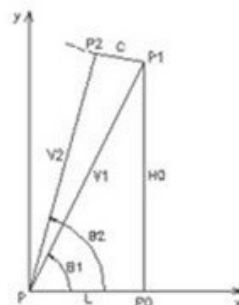
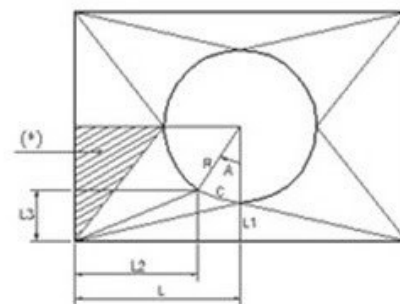
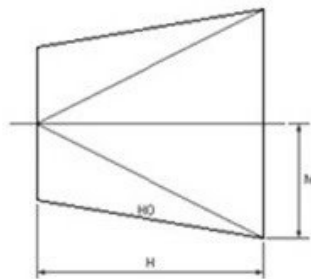
OUTPUT
GRAPHIC CONSTRUCTION AND FORMULAS
HC
Y
HB
Y0
L2
L1
L
K
R2
R1
J
X
A
E
X = R1 x A
J = R1 x sinA
L = E + R1 x cosA
K = √L² + J²
L1 = L x R2/K
L2 = L1 − L
Y0 = HC x L2/L1
Y = HB − Y0

PROGRAM: CICONX.lsp

```
(DEFUN C:CICONX ()
   (GRAPHSCR)
      (SETQ R (GETREAL "\nIMMETTERE RAGGIO R: ")
            RO (GETREAL "\nIMMETTERE RAGGIO RO: ")
            B (GETREAL "\nIMMETTERE ANGOLO B: ")
            P1 (GETPOINT "\nPUNTO INIZIALE: ")
      )
         (SETQ PO (LIST 0 0))
         (SETQ A 0)
         (SETQ L (* R (SIN A)))
         (SETQ H (* R (COS A)))
         (SETQ R1 (SQRT (+ (* L L) (EXPT (+ RO H) 2))))
         (SETQ V1 (/ R1 (SIN (* (/ PI 180) B))))
         (SETQ Q (ATAN (/ L (+ RO H))))
         (SETQ Q1 (/ (* Q R1) V1))
         (SETQ P1 (POLAR PO Q1 V1))
         (SETQ A (/ PI 90))
            (REPEAT 180
               (SETQ L (* R (SIN A))
                     H (* R (COS A))
                     R1 (SQRT (+ (* L L) (EXPT (+ RO H) 2)))
                     V1 (/ R1 (SIN (* (/ PI 180) B)))
                     Q (ATAN (/ L (+ RO H)))
                     Q1 (/ (* Q R1) V1)
                     P2 (POLAR PO Q1 V1)
               )
                  (COMMAND "LINE" P1 P2 "")
                  (SETQ P1 P2)
                  (SETQ A (+ A (/ PI 90)))
            )
                  (COMMAND "ROTATE" "ALL" "" PO 90 "")
                  (COMMAND "ZOOM" "ALL" "")
                  (PRINC)
)
```

OUTPUT
GRAPHIC CONSTRUCTION AND FORMULAS
R1
P0
B
V1
R1
A
Q
R
L
R0
H
L = R x sinA
H = R x cosA
R1 = √(R0+H)² + L²
V1 = R1/sinB
Q = atan(L/(R0+H))
Q1 = (QxR1)/V1
P1 (POLAR P0 Q1 V1)

PROGRAM: RACQTS.lsp

```
(DEFUN C:RACQTS ()
  (GRAPHSCR)
    (SETQ R (GETREAL "\nIMMETTERE RAGGIO R: ")
          L (GETREAL "\nIMMETTERE SEMILATO L: ")
          M (GETREAL "\nIMMETTERE SEMILATO M: ")
          H (GETREAL "\nIMMETTERE ALTEZZA H: ")
          P (GETPOINT "\nPUNTO INIZIALE: ")
    )
      (SETQ P (LIST 0 0))
      (SETQ P0 (LIST L 0))
      (SETQ L1 (- M R))
      (SETQ H0 (SQRT (+ (* H H) (EXPT L1 2))))
      (SETQ P1 (LIST L H0))
      (COMMAND "LINE" P P0 "")
      (COMMAND "LINE" P0 P1 "")
      (SETQ B1 (ATAN (/ H0 L)))
      (SETQ V1 (SQRT (+ (* L L) (EXPT H0 2))))
      (SETQ A (/ PI 180))
      (SETQ C (* R A))
        (REPEAT 90
          (SETQ L2 (- L (* R (SIN A)))
                L3 (- M (* R (COS A)))
                V2 (SQRT (+ (+ (* L2 L2) (EXPT L3 2)) (EXPT H 2)))
                P (/ (+ (+ C V1) V2) 2)
                D1 (- P C)
                D2 (- P V1)
                D3 (- P V2)
                S (SQRT (/ (* D1 (* D2 D3)) P))
                T (/ S D1)
                B2 (+ (* (ATAN T) 2) B1)
                P2 (POLAR (LIST 0 0) B2 V2)
          )
            (COMMAND "LINE" P1 P2 "")
            (SETQ P1 P2)
            (SETQ V1 V2)
            (SETQ B1 B2)
            (SETQ A (+ A (/ PI 180)))
        )
            (SETQ H1 (SQRT (+ (* L2 L2) (EXPT H 2)))
                B2 (+ (ATAN (/ H1 M)) B1)
                P2 (POLAR (LIST 0 0) B2 M)
            )
                (COMMAND "LINE" P1 P2 "")
```

```
		(COMMAND "LINE" P2 (LIST 0 0) "")
		(COMMAND "ZOOM" "ALL" "")
		(PRINC)
)
```

OUTPUT

GRAPHIC CONSTRUCTION
AND FORMULAS

$$L1 = M - R$$

$$H0 = \sqrt{H^2 + L1^2}$$

$$B1 = \text{atan } H0/L$$

$$V1 = \sqrt{L^2 + H0^2}$$

$$C = R \times A$$

$$L2 = L - R \times \sin A$$

$$L3 = M - R \times \cos A$$

$$V2 = \sqrt{L2^2 + L3^2 + H^2}$$

$$P = (C+V1+V2)/2$$

$$S = \sqrt{(P-C)\times(P-V1)\times(P-V2)/P}$$

$$T = S/(P-C)$$

$$B2 = 2 \times \text{atan}T + B1$$

(*) Triangolo rettangolo finale dello sviluppo, avente cateti M ed

$$H1 = \sqrt{H^2 + L2^2}$$